

# NASA TECH BRIEF

## Marshall Space Flight Center



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### Fill-In Binary Loop Pulse-Torque Quantizer

#### The problem:

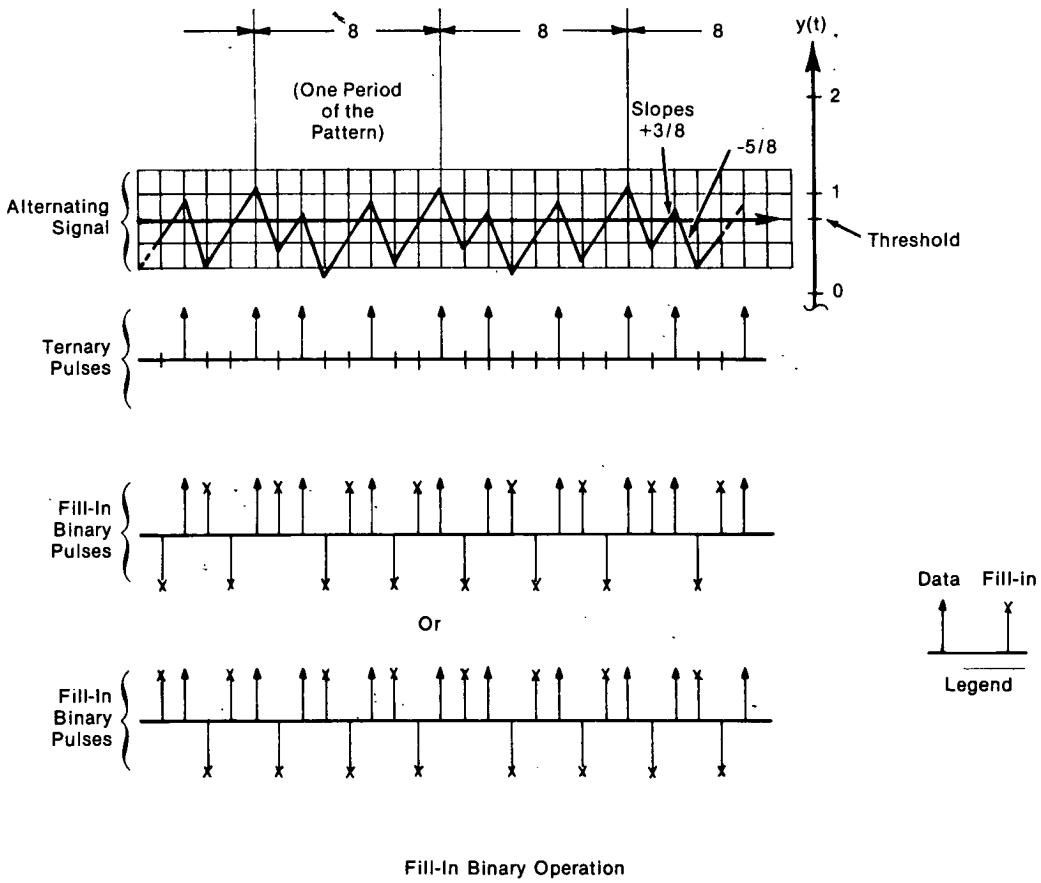
Binary delta modulators used as pulse-torque loops with gyroscopes and accelerometers have two problems. First, the mixing of information-carrying pulses with arbitrary pulses (required for binary operation) delays the communication of some information until it can be distinguished from the zero mode pattern of the quantizer. Second, the bias of the switch torque-generator combination can be pattern sensitive, giving a dead zone for low input rates.

#### The solution:

A fill-in binary (FIB) loop has been developed which is a delta type of pulse-torque quantizer. It combines the advantages of binary current switching with ternary quantization.

#### How its done:

The FIB loop provides a constant heating of the torque generator, an advantage of the binary current switching. At the same time it avoids the mode-related dead zone and data delay of the binary, an advantage of ternary quantization.



Fill-In Binary Operation

(continued overleaf)

The nature of the FIB is that it does not necessarily communicate data corresponding to each pulse to the feedback elements. Instead, the spaces which would occur in the ternary are filled in with the current pulses of the alternating sign without transmitting any data. These pulses do not affect operation so long as they average to zero and are prevented from interfering with the formation of the ternary output. If this is accomplished, the data output format is indistinguishable from that of a ternary scheme. As a consequence, FIB logic can replace the ternary in a guidance system without system modification. It also has the same sampling error as the ternary rather than the higher error of the ordinary binary.

The FIB system includes an ordinary ternary interrogation section having two comparators with thresholds at, say, plus and minus three-fourths of a pulse. By itself, this would give a pulse pattern like that shown in the illustration in response to three-eighths maximum input rate. When no output data are required, the task of the FIB logic is to call for a feedback pulse but to block data to the computer. The filled-in feedback must alternate in sign in order to minimize its effects on the loop.

The idea of the FIB can be easily illustrated. Alternating plus and minus pulses are filled in as shown in the periods having no torque command. The added pulses are to alternate in sign regardless of intervening pulses commanded by the interrogator. The two correct solutions are shown under the ternary pulses. A significant characteristic of these patterns is that, although the data has a period of 8 interrogate cycles, the filled-in pattern has a period of 16.

The only complication in the implementation of the FIB system is that, if uncorrected, the filled-in pulses would move the actuating signal out of the dead zone and trigger extraneous pulses. To prevent this, an offset of plus or minus one-half pulse is added to the thresholds, the sign depending on the sign of the fill-in pulse. In effect, this gives a zero moding pattern.

**Note:**

Requests for further information may be directed to:

Technology Utilization Officer  
Marshall Space Flight Center  
Code AT01  
Marshall Space Flight Center, Alabama 35812  
Reference: B75-10037

**Patent status:**

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